Environmental Sustainability and Governance via Enterprise Architecture

(Position Paper)

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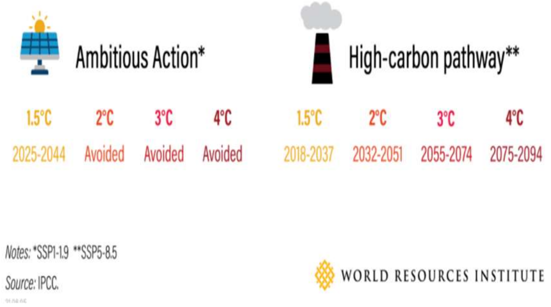
Abstract

This paper seeks to create an awareness among the leaders in IT that sustainability is not just about tailpipe emissions, renewable fuels, and recycling. IT leaders need to understand that the Architecture and Design choices they make around software development and processes also have an impact on the environment. IT leaders need to understand the cradle to grave impacts of their choices - from mineral mining for computing hardware, disk drives, and telecommunication equipment; to the power needs for operating a data center, to the disposal of hardware. IT leaders and Architects need to consider their Non-Functional Requirement (NFR) choices for resiliency, data retention, bandwidth, and transaction concurrency via the framework of Enterprise Architecture to have a measurable impact on emissions reduction.

1. Introduction

We believe that from 2021, environmental sustainability is no longer a choice, it is a governmental, business, and individual imperative. One of the robust findings of the IPCC's *Climate Change 2021* report is the attribution of observed warming to human activities [1]. Figure 1 shows when temperature thresholds might be reached subjected to human action i.e., carbon emissions today and in the future.



Notes: *SSP1-1.9 **SSP5-8.5

Source: IPCC.

Figure 1- [1]

We must take immediate transformational actions to limit global warming to 1.5 degrees C by the end of this century. The global consortium CDP [1] that maintains a global voluntary environmental disclosure system, estimates that climate-related weather events are expected to cost businesses $1.3 trillion by 2026 [2].

The carbon footprint of the Information Technology and Communications (ICT) sector is estimated to be about 1.4% of the global greenhouse gas emissions, including the whole life cycle for all parts of the sector [3] . Research conducted by the Global e-Sustainability Initiative (GeSI) [2] indicates that continued developments and adoption of carbon deficient initiatives in the ICT space can enable a 20% reduction of global Carbon Dioxide Equivalents (CO_2e comprising of carbon dioxide, methane, nitrous oxide, and ozone) emissions by 2030, holding emissions at 2015 levels [4].

As of 2021, 13,000 plus [5] companies are leveraging the Greenhouse Gas Protocol (GHG) [3] based standards for reporting their Scope 1 (direct,

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[1] https://www.cdp.net/en

[2] https://gesi.org/

[3] https://ghgprotocol.org/

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company-owned) and 2 (indirect, company-owned) CO_2e emissions.

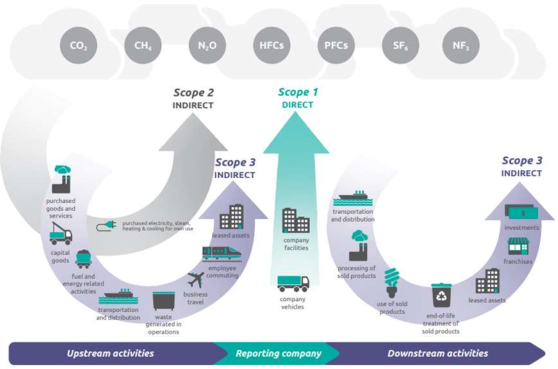

Figure 2 - Overview of GHG Protocol scopes and emissions across the value chain[4]

Scope 3 emissions (unowned, indirect upstream and downstream CO_2e emissions) during the value-chain of a company's offered product/service are not a necessary disclosure for CDP. These are prone to significant under or incorrect calculation due to lack of data, life-cycle assessments, missed focus, and optimistic estimations. Even tech companies that are voluntarily reporting their Scope 3 emissions are underreporting to the order of 390 megatons of CO_2e, equivalent to the carbon footprint of Australia [6]. As shown in the chart in Figure 3, Scope 3 CO_2e constitute more than 50% of almost all companies' emissions leading up to 90% for some others.

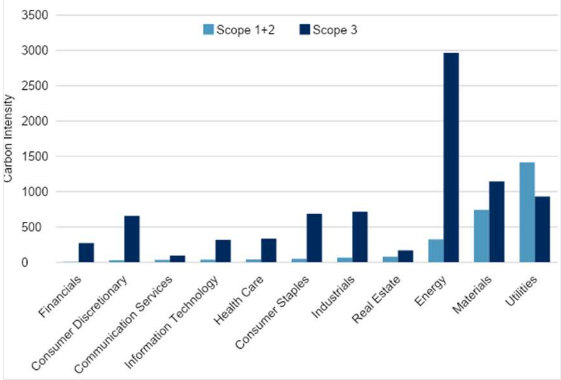

Figure 3 - Sector Breakdown of Scope 1+2 and Scope 3 Emissions Source: S&P Global, Dec. 2020 [4]

Though about 21% of the world's 2,000 largest publicly listed companies have pledged net zero commitments by 2050, only about 6% of these are believed to include Scope 3 emissions in this math [2]. Organizations are missing turnkey opportunities for improvement and business by not calculating and reporting their Scope 3 emissions. How can processes and metrics be instituted to goad sustainable behavior and reduce CO_2e emissions in the digital value chain cycle? This is where the Enterprise Architecture practice of an organization must play a significant role.

2. Sustainability in architecture and design – the past and present

Sustainability in software architecture has been an existing yet evolving, and somewhat confusing term, open to interpretation by various parties. Sustainability is typically interpreted as the longevity of software in production satisfying requirements, costs, ROIs and maintenance. It has been an over-arching metric related to many of the non-functional requirements (usability, maintainability, reliability). There are quite a few reference architectures, guidelines, and frameworks with robust examples and solutions [7] for consideration in software development and its practices to enable sustainability i.e., longevity of software. So, going beyond bespoke software sustainability (longevity), we believe that environmental sustainability must also be considered. Decisions about effective software maintenance can also influence the environmental impact of solutions. Adaptive software maintenance involving technical upkeep, can improve a software system's effect on the environment. Adaptive maintenance can be a significant burden to cost and typically makes up about 25% of maintenance costs [8], so potential reduction in environmental impact can help to recoup some ROI.

We propose that "eSustainability" is considered as a separate NFR to formally bring "environmental sustainability" awareness and tracking into the governance of digital systems.

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[4] https://ghgprotocol.org/

3. "eSustainability" via Enterprise Architecture – the immediate future

Enterprise Architecture (EA) has been defined as "the glue between business and IT architecture" [9]. In organizations with an EA practice, the goal is to tightly interlink business and IT by means of governance (people, frameworks, policies) to balance business, technical, and organizational considerations. Now, environmental sustainability goals are being espoused as business objectives in addition to the voluntary reporting of sustainability metrics for customers, investors and governments. Statistics from 2020 indicate that 88% of publicly traded companies, 79% of venture and private equity-backed companies, and 67% of privately-owned companies have Environmental, Social, Governance (ESG) initiatives in place [10]. We believe that these business objectives related to environmental sustainability must be aligned with the EA practice. Whether architecting for Sustainability or other NFRs, the process and technology are continually evolving. Understanding the process, following the evolution, making adjustments, and creating awareness in the enterprise are all critical for success. In Figure 4, we outline a simple, constructive methodology for organizations to follow:

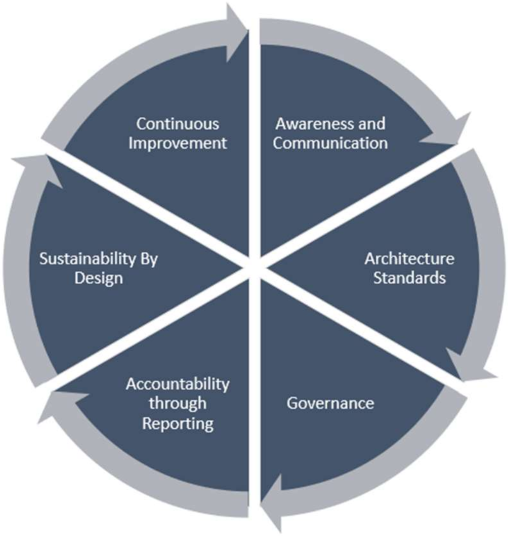

Figure 4 - Awareness and Governance cycle supporting continuous integration of Architecture Sustainability

Awareness and Communication: First and foremost, organizations need to create awareness outlining ESG initiatives so that thinking is pervasive within the organization. The United Nations Life Cycle Initiative[5] defines Life Cycle Thinking (LCT) as "a way of thinking that includes the economic, environmental, and social consequences of a product or process over its entire life." It is fed by Life Cycle Assessments (LCA) which is the scientific process of understanding the environmental impacts that occur because of the materials that move through our economy. We need to create awareness and communicate Life Cycle Thinking in Architecture and Design of digital systems.

Architecture Standards: Supporting ESG goals requires standards so that Architects have a 'North Star' to reach for. Using the practice of Business Capability Modeling, Architects in EA should translate the E goals of ESG into required solutions. Such capabilities could then be realized in increments on the architecture roadmap. These solutions can target reduced and/or limited Scope 3 emissions in the value chain including those of home-grown or 3rd party "as-a-service" solutions (IaaS, PaaS and SaaS).

Consider the case when there is a requirement to build and host an application in a public cloud (datacenter). Today, apart from the capabilities offered by some public clouds like GCP (Carbon Footprint, Unattended Project Reminder), there is no defined paradigm/framework for IT professionals to realize business' sustainability goals. The "eSustainability" NFR should address questions encompassing "What is the acceptable range/not-to-exceed limit for the gross emissions (by electricity usage) of the solution on-prem/cloud?", "Is there any intrinsic/extrinsic value to this NFR category for this project?", "How can the footprint of this solution's architecture be measured and reported?", etc. For evaluating SaaS solutions, specific questions should be asked of the vendor related to emissions, offsets, and consumption metrics. The Sustainability officers of the organization can help determine the multitude of questions in this category to align with strategic and tactical business goals.

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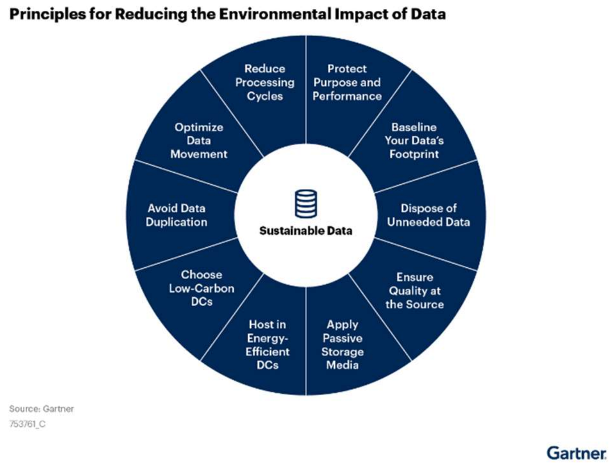
[5] https://www.lifecycleinitiative.org/

Governance: Setting standards to attain goals works best when there is a Governance structure in place. We believe that it is time a new domain called Sustainability be added to the Solution Architecture Review process, apart from the existing Business, Application, Information, Infrastructure, and Information Security domains. As an extension of Business Criticality classification tiers (Tier 1 Mission Critical to Tier 4 non-critical applications) organizations can align scope 3 emission reduction targets. In such a framework, mission critical applications' scope 3 targets would be low and less critical applications can have more aggressive scope 3 reduction targets.

Accountability Through Reporting: Establishing Standards and Governing the organization's goals support Reporting and ultimately being accountable to stakeholders.

Sustainability by Design: Much like security, Sustainability can't be an afterthought. Figure 5 illustrates the principles of reducing the environmental impact of data as suggested by Gartner [13].


Principles for Reducing the Environmental Impact of Data

Reduce Processing Cycles
Protect Purpose and Performance
Baseline Your Data's Footprint
Dispose of Unneeded Data
Ensure Quality at the Source
Apply Passive Storage Media
Host in Energy-Efficient DCs
Choose Low-Carbon DCs
Avoid Data Duplication
Optimize Data Movement
Sustainable Data
Gartner

Source: Gartner
753761_C

Figure 5-Gartner®, Principles for Reducing the Environmental Impact of Data

Though principles like optimization of data movement, avoiding data duplication are well-established in Information Architecture, these and others need to be adopted tactically and strategically in the short order.

Continuous Improvement*:* Technology, process, goals, and standards continue to evolve and so should the enterprise's operation.

Awareness and Communication*:* Awareness and communication should transcend the enterprise and be an ever present influence.

4. Conclusion:

Many organizations allocate budget for ESG initiatives, typically reduction of Scope 1 and Scope 2 emissions. Allocating a small piece of that pie to support robust architecture aimed at reducing Scopes 2 and 3 emissions will go a long way in helping companies meet their ESG and therefore business goals. It should be the imperative of the organization and the EA practice to provide methodologies and tools to environmentally conscious employees, and to those who need added motivation, for the practical realization of such objectives.

With the exponential growth in computing needs we must act before it is too late. The initial industrial revolution propelled the world forward at significant cost to the environment; let us learn from that experience and neutralize the impacts of this Third Industrial Revolution – The Digital Revolution [11], and responsibly usher in the soon-to-come Fourth Industrial Revolution.

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